SID 62-786

APOLLO SUPPORT MANUAL

SM 2A2-03

FLIGHT OPERATION

30 June 1962

NAS9-150

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

FOREWORD

This manual is arranged to provide the necessary instructions and procedures for all phases of the mission for each spacecrew member. These procedures are presented in an actual or logical sequence. The normal procedures in section II and the emergency procedures in section III are provided with necessary detail. A condensed checklist supplement of amplified procedures in sections II and III of this manual is available for the crew members during flight. The in-flight maintenance procedures in section IV provide fault isolation and repair instructions consistent with the capability of crew members. The amplified procedures in section IV are also included and condensed in the checklist supplement to the flight operation manual. (Refer to SM 2A2-03-CL.) The instructions and procedures listed in this manual are not intended to teach flight or maintenance techniques, but rather to provide pertinent data for normal and emergency flight conditions.

NOTE

The instructions and procedures outlined in the flight operation manual will remain incomplete until detailed information is provided for spacecraft systems, flight characteristics and controls, and display panels.

- The mission phases leading up to the Lunar Landing Mission are presented in this manual. When more data becomes available it may be desirable to prepare separate flight operation manuals to cover mission phases.

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LIST OF ILLUSTRATIONS

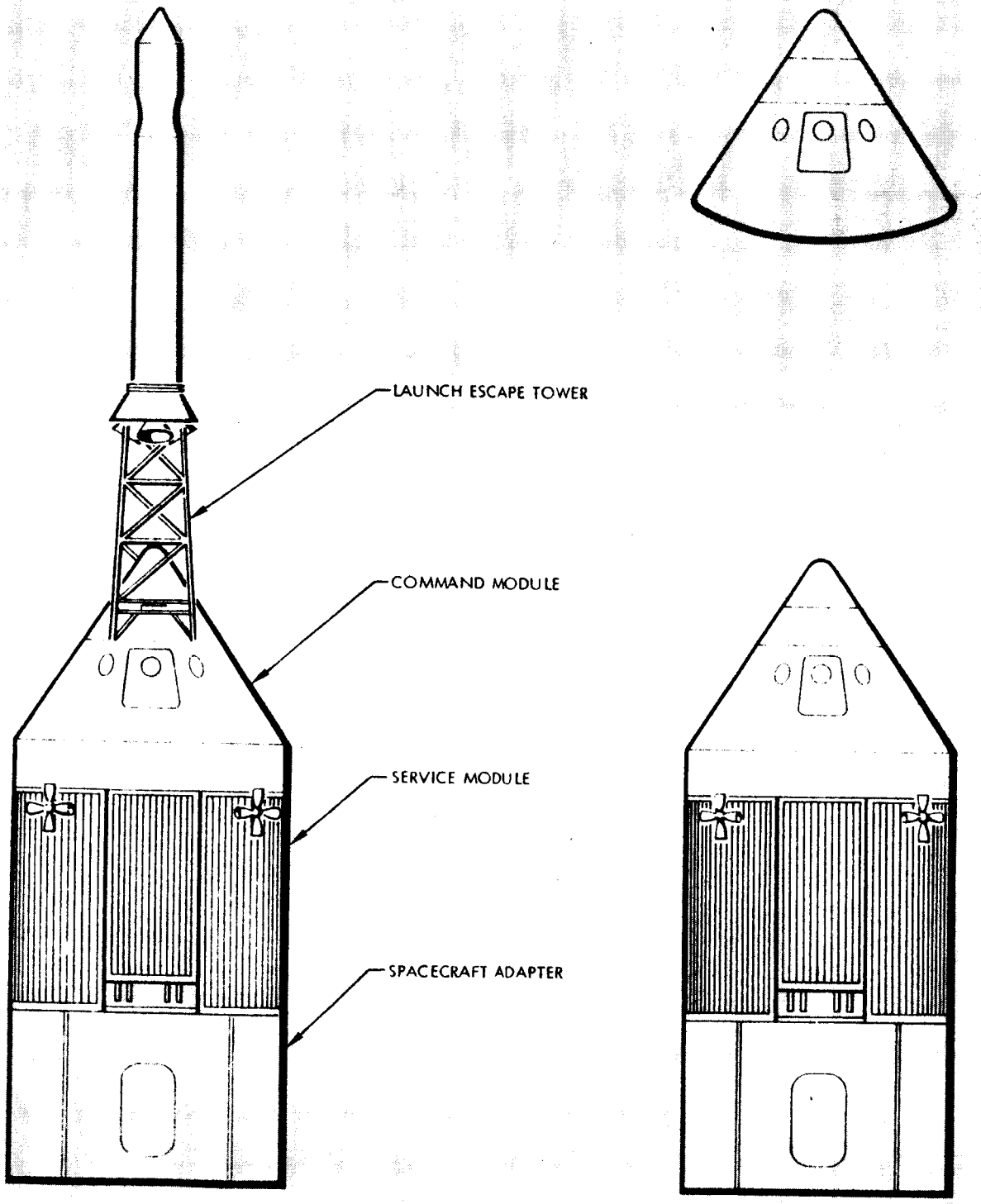


Figure 1-1. Spacecraft Arrangement (Typical)

SECTION I

MISSION DESCRIPTION

Contents

EARTH ORBITAL MISSION

The earth orbital mission, using the Saturn C-1 booster, is based on a series of flight phase sequences starting with the spacecraft ascent and continuing with earth orbit, orbit ejection, de-orbit coast, entry and recovery phases. Figure 1-1 shows a typical spacecraft configuration. A typical earth orbital flight trajectory which also includes the various events that occur during the overall mission is shown in figure 1-2.

PHASE SEQUENCES

ASCENT. The ascent phase includes the events from launch vehicle lift-off to beginning of earth orbit. The lift-off is started with ignition of the first-stage (S-1) propulsion engines. After successful lift-off, and at predetermined time periods, the first stage is cut off, first-stage separation occurs; the second-stage (S-IV) ignition starts, and the launch escape tower is jettisoned after first stage separation.

EARTH ORBIT. The earth orbit phase, at altitudes between 90 to 200 nautical miles, begins with the termination of second-stage burning and its separation from the spacecraft. Immediately after the second-stage separation, orbital operations are conducted by the spacecrew to include spacecraft systems monitoring and maintenance, orbital adjustments, attitude control maneuvers, establishment of communications with the Ground Operation Support Systems (GOSS), and mission objectives. Orbital transfer may be accomplished using the service propulsion system to altitude as high as 400 nautical miles. Upon completion of the mission objectives, preparations are made for orbit termination which includes navigation computations, final attitude maneuvers, and final checks of the spacecraft systems.

ORBIT EJECTION. Orbit ejection is a powered flight phase to place the spacecraft on a de-orbit coast trajectory. To accomplish this trajectory, the spacecraft is aligned opposite to the velocity vector by utilizing the reaction control jets. After the correct attitude orientation has been achieved, the service propulsion system is ignited to decelerate the spacecraft so as to satisfy the correct entry position and velocity vector.

DE-ORBIT COAST. The de-orbit coast phase starts with cutoff of the service propulsion system while the spacecraft continues to descend from orbit until just prior to the entry phase. At approximately 5 minutes before the entry phase begins, the service module is separated from the command module. The pre-entry orientation includes the initiation and monitoring of the service module separation, required attitude control maneuvers to establish an entry flight path angle, and spacecrew preparation for the entry phase.

ENTRY PHASE. The entry phase includes certain maneuvers as the command module penetrates into the earth's atmosphere prior to entering the recovery phase. During this phase, roll maneuvers are accomplished for range control. After these maneuvers are made, the descent is continued to the recovery phase.

RECOVERY. The recovery phase commences with stabilization of the command module upon deployment of the drogue chute. When a safe attitude and altitude is attained, the main chute is deployed and the spacecrew continues communication with GOSS. Recovery aid deployment is a combination of recovery devices to aid the recovery ground crews in tracking the module to the impact area. The impact event consists of the touchdown, system shutdown, and release of the main chute. The method of egress is determined by the spacecrew, based on the conditions of impact and the geographical location for recovery.

CIRCUMLUNAR MISSION

The circumlunar mission using the Saturn C-5 booster is based on a series of flight phases consisting of ascent to 100 nautical miles, parking orbit, trans-lunar injection, translunar coast, transearth coast, entry, and recovery. The ascent, entry, and recovery phases are similar to those events described for the earth orbital mission, except entry on all lunar missions is made at "near escape" velocities. Additional data concerning the circumlunar mission will be furnished at a later date.

LUNAR ORBIT MISSION

The lunar orbit mission is based on a series of flight phases consisting of ascent, parking orbit, translunar injection, translunar coast, lunar orbit injection, lunar orbit, transearth injection, transearth coast, entry, and recovery. Data relative to these phases will be supplied at a later date.

LUNAR LANDING MISSION

Data to be supplied at a later date.

SECTION II

NORMAL PROCEDURES

Contents

NOTE

Text material and procedures, for which headings only are included herein will be provided when data becomes available.

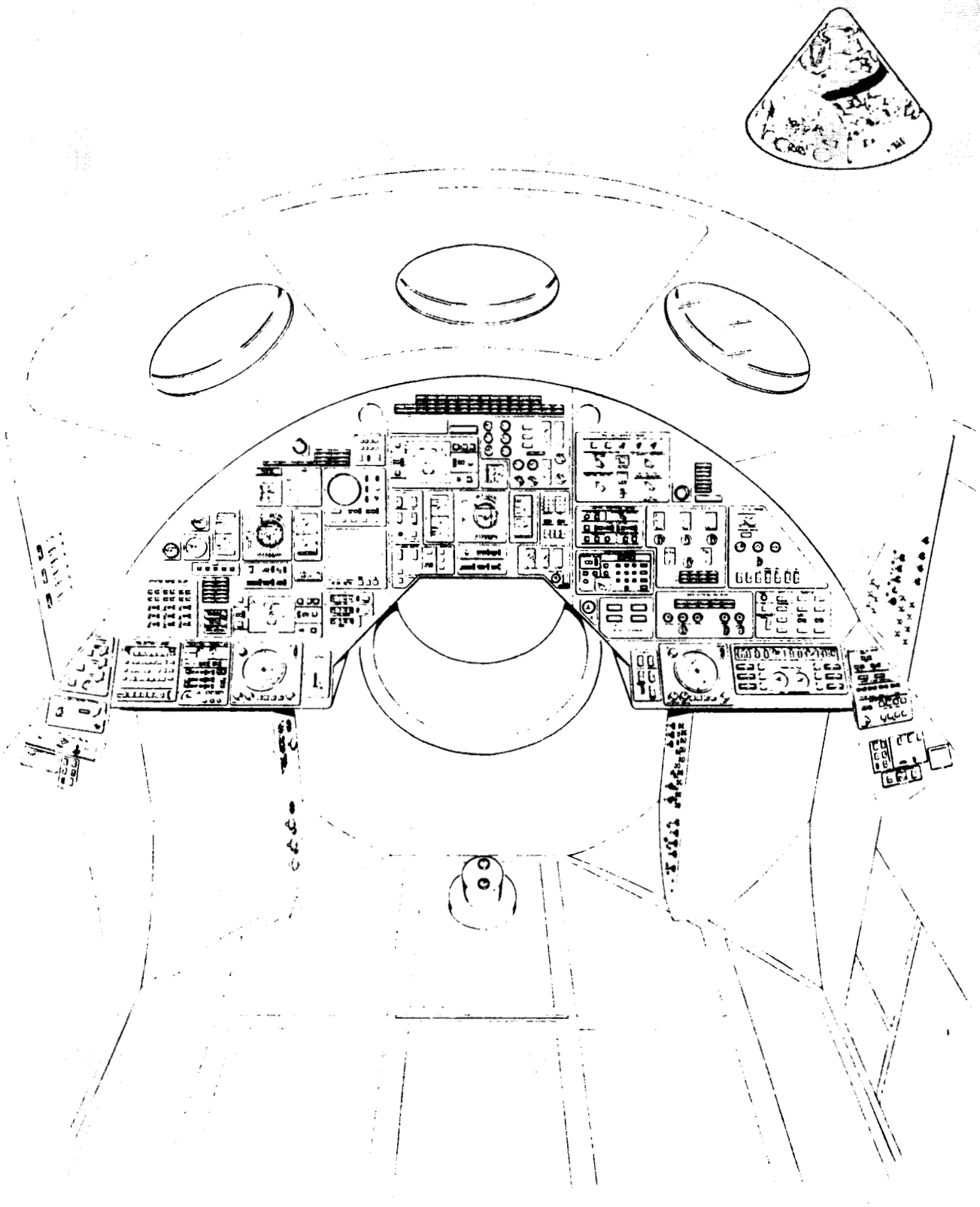
- Refer to section N-1 of SM 2A2-03-CL for condensed checklist of amplified procedures contained in this section.

GENERAL

The phase portions for the Earth Orbital, Circumlunar, Lunar Orbital, and Lunar Landing Missions are individually separated in this section. The spacecrew members must use the applicable phases relating to the "Mission". Prelaunch and countdown checks apply to all launchings from the Launch Control Center (LCC). The spacecraft instruments and panels are shown in figure 2-1.

PRELAUNCH CHECKS

The prelaunch checks involve pre-entrance, entrance, and interior inspection checks which are performed by the spacecrew prior to starting the countdown. These checks should be conducted in the order presented to insure adequate coverage with minimum effort by crew personnel.



SM-2A2-15

Figure 2-1. Instruments and Panels (Typical)

PRE-ENTRANCE

The pre-entrance checks are made prior to entering the spacecraft to ascertain engineering status and to make certain that the required safety checks are performed.

Procedure:

ENTRANCE

The entrance checks are conducted to satisfy personnel accommodations, to confirm adequate flight safety provisions, insure that there is intercommunication between the spacecrew and the ground control center, that spacecrew suit connections are completed, and that there is an adequate oxygen supply. All necessary safety pins are removed and presented to ground crew personnel prior to hatch installations.

Procedure:

INTERIOR INSPECTION

The interior inspection is performed during installation and sealing of the command module access hatch with the handle in the closed position. The sequence of actions will be arranged in a chronological order starting from the left side of the Pilot-Commander to ascertain proper operation of indicator panels and controls. All checks will be monitored by the Launch Control Center personnel. Figure 2-2 shows typical spacecraft controls. For a complete description of spacecraft controls and panels, refer to the "Spacecraft Description Manual."

Procedure:

COUNTDOWN

The countdown checks will be monitored by the spacecrew as they are read by the LCC director. Response to these checks by crew personnel will confirm go and no-go indications as they are displayed on the spacecraft instruments.

ESCAPE SYSTEM CHECK

Procedure:

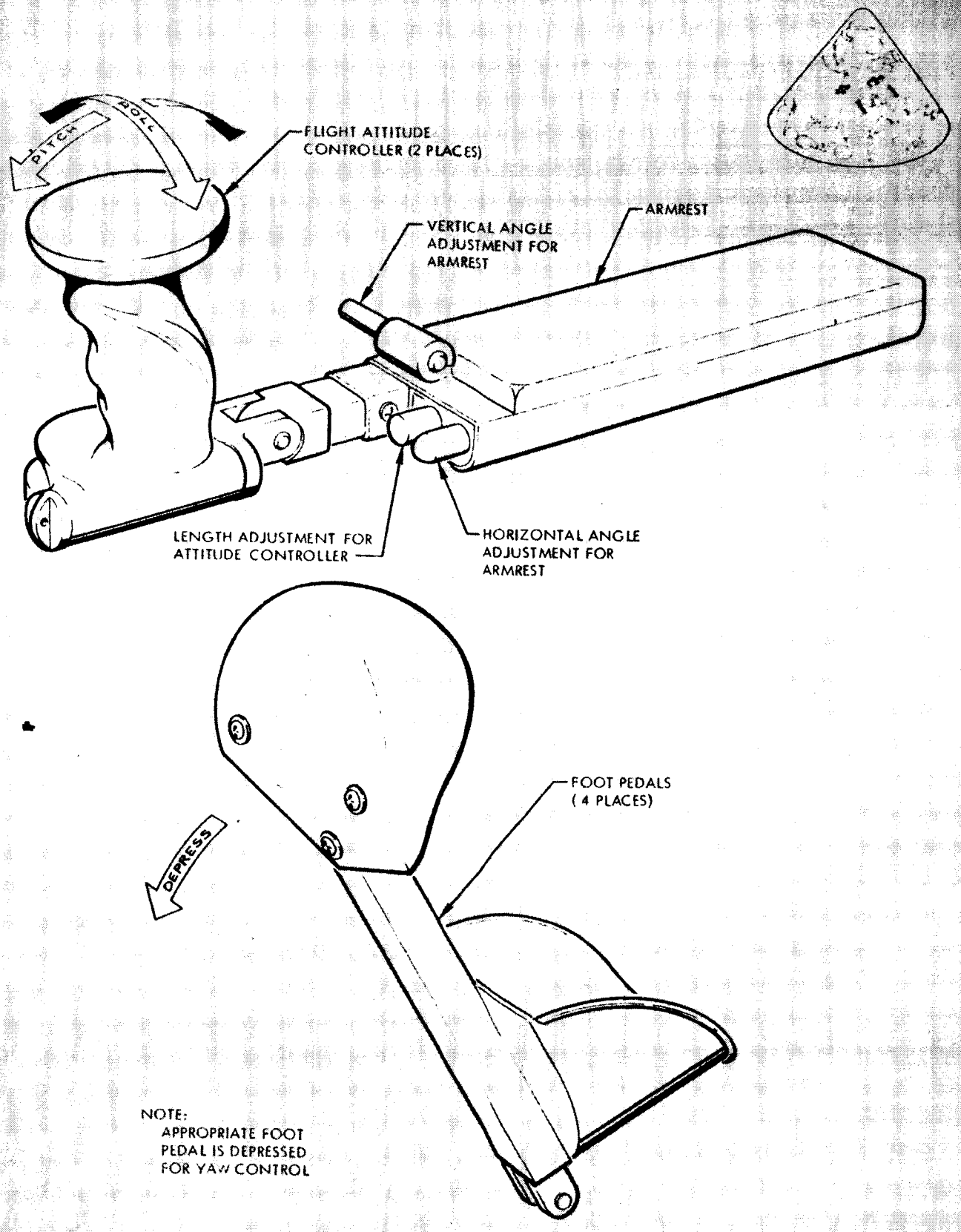


Figure 2-2. Spacecraft Controls (Typical)

RESTRAINT CHECK

Procedure:

EARTH ORBITAL MISSION PHASES

If spacecrew members are to participate in an Earth Orbital Mission, continue with phase procedures listed for this mission. Otherwise, refer to applicable mission. For phase description concerning the earth orbital mission, refer to section I.

ASCENT

Text. Will include use of Saturn C-1 as launch vehicle.

Procedure: (Monitoring)

EARTH ORBIT

Text. These procedures will include all actions of the spacecrew between altitudes of 90 to 400 nautical miles.

Procedure: (Automatic and manual stabilization control)

ORBIT EJECTION

Text.

Procedure:

DE-ORBIT COAST

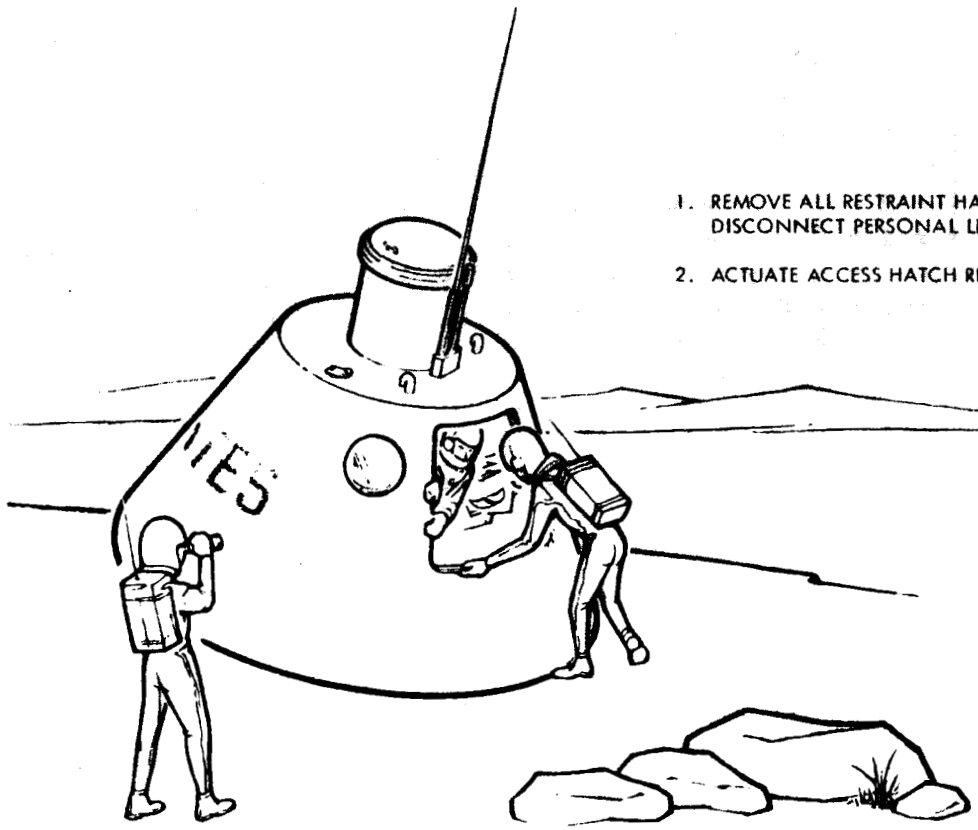
Text.

Procedure:

ENTRY

Text.

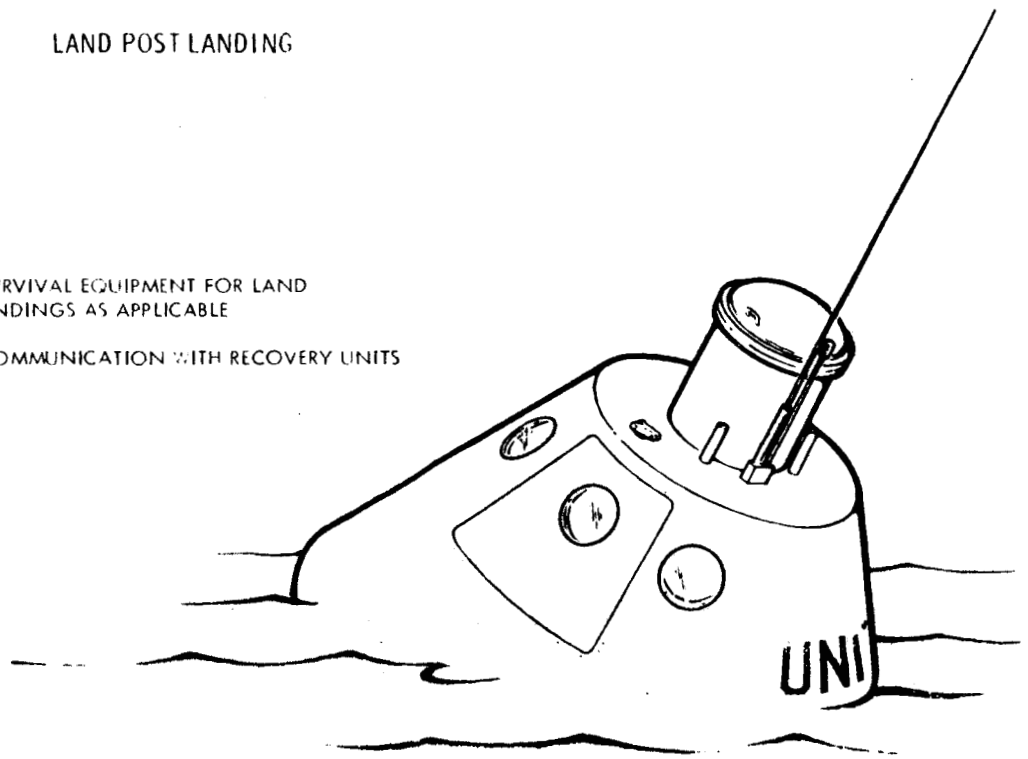
Procedure:



1. REMOVE ALL RESTRAINT HARNESS AND DISCONNECT PERSONAL LEADS
2. ACTUATE ACCESS HATCH RELEASE HANDLE

LAND POST LANDING

3. DETERMINE SURVIVAL EQUIPMENT FOR LAND OR WATER LANDINGS AS APPLICABLE
4. CONTINUE COMMUNICATION WITH RECOVERY UNITS



WATER POST LANDING

SM-2A2-13

Figure 2-3. Normal Egress (Typical)

RECOVERY

Text.

Procedure:

RETRIEVAL AND POSTFLIGHT

Except in an emergency, the spacecrew will remain in the command module during water landings until the recovery unit arrives at the scene. For normal egress procedures see figure 2-3. Procedures to be followed prior to and after evacuation of command module, relative to survival, will be provided when available. For emergency escape procedures, refer to section III.

CIRCUMLUNAR MISSION PHASES

If the spacecrew members are to participate in a Circumlunar Mission, continue with phase procedures listed for this mission. Otherwise, refer to applicable mission.

ASCENT

Text. This phase is similar to that described in Earth Orbital Mission, except for change of launch vehicle to Saturn C-5.

Procedure:

PARKING ORBIT

Text. The parking orbit will extend to approximately 100 nautical miles.

Procedure:

TRANSLUNAR INJECTION

Text.

Procedure:

TRANSLUNAR COAST

Text.

Procedure:

TRANSEARTH COAST

Text.

Procedure:

ENTRY

Text. This phase is similar to that described in Earth Orbital Mission, except for "near earth" entry velocity.

Procedure:

RECOVERY

Text. This phase is similar to that described in Earth Orbital Mission.

Procedure:

RETRIEVAL AND POSTFLIGHT

Text. This phase is similar to that described in Earth Orbital Mission.

Procedure:

LUNAR ORBITAL MISSION PHASES

If spacecrew members are to participate in a Lunar Orbital Mission, continue with phase procedures listed for this mission. Otherwise, refer to applicable mission.

ASCENT

Text. This phase is similar to that described in Earth Orbital Mission.

Procedure:

PARKING ORBIT

Text.

Procedure:

TRANSLUNAR INJECTION

Text.

Procedure:

TRANSLUNAR COAST

Text.

Procedure:

LUNAR ORBIT INJECTION

Text.

Procedure:

LUNAR ORBIT

Text.

Procedure:

TRANSEARTH INJECTION

Text.

Procedure:

TRANSEARTH COAST

Text.

Procedure:

ENTRY

Text.

Procedure:

RECOVERY

Text.

Procedure:

RETRIEVAL AND POSTFLIGHT

Text.

Procedure:

LUNAR LANDING MISSION PHASES

Data to be supplied at a later date.

SECTION III

EMERGENCY PROCEDURES

Contents

NOTE

Text material and procedures, for which headings only are included herein, will be provided when data becomes available.

- Refer to section E-1 of SM 2A2-03-CL for condensed checklist of amplified procedures contained in this section.

ASCENT

OFF-PAD ABORT (PRIOR TO TOWER JETTISON)

Text. This includes all aborts prior to jettisoning of the launch escape tower.

Procedure:

SUB-ORBITAL ABORT (AFTER TOWER JETTISON)

Text. This includes all aborts after jettisoning of the launch escape tower, but prior to going into orbit.

Procedure:

LAUNCH ESCAPE TOWER FAILS TO JETTISON

Text.

Procedure:

SPACECRAFT FAILS TO SEPARATE FROM BOOSTER

Text.

Procedure:

EARTH ORBIT

ABORT FROM ORBIT

Text.

Procedure:

STABILIZATION SYSTEM EMERGENCY OPERATION

Text.

Procedure:

ENVIRONMENTAL CONTROL SYSTEM EMERGENCY OPERATION

Text.

Procedures: (Cabin depressurization, cabin pressurization, emergency oxygen, and water management procedures.)

ELECTRICAL SYSTEM EMERGENCY OPERATION

Text.

Procedures: (Main battery failure, standby battery failure, main inverter failure, standby inverter failure, and primary electrical failure procedures.)

COMMUNICATION SYSTEM EMERGENCY OPERATION

Text.

Procedure:

NAVIGATION SYSTEM EMERGENCY OPERATION

Text.

Procedure:

PROPULSION SYSTEM EMERGENCY OPERATION

Text.

Procedure:

EJECTION

SPACECRAFT RETROGRADE SEQUENCE FAILS TO START

Text.

Procedure:

SPACECRAFT FAILS TO ATTAIN RETROGRADE ATTITUDE

Text.

Procedure:

SERVICE PROPULSION ENGINES FAIL TO IGNITE

Text.

Procedure:

SPACECRAFT FAILS TO MAINTAIN RETROGRADE ATTITUDE

Text.

Procedure:

SERVICE MODULE FAILS TO JETTISON

Text.

Procedure:

COMMAND MODULE CANNOT MAINTAIN RE-ENTRY ATTITUDE

Text.

Procedure:

RECOVERY

DROGUE CHUTE DEPLOYMENT FAILURE

Text.

Procedure:

PARACHUTE CLUSTER DEPLOYMENT FAILURE

Text.

Procedure:

DROGUE CHUTE FAILS TO JETTISON

Text.

Procedure:

PARACHUTE FAILS TO JETTISON

Text.

Procedure:

EMERGENCY EGRESS

In the event that spacecrew personnel must commit themselves to an emergency egress from the spacecraft, follow the procedures described in figure 3-1.

NOTE

Procedures for salvage and/or destruction of special equipment and pertinent data will be provided when available.

1. REMOVE ALL RESTRAINT HARNESS AND DISCONNECT PERSONAL LEADS
2. ACTUATE ACCESS HATCH AND AIR LOCK RELEASE CONTROLS
3. EVACUATE EMERGENCY SURVIVAL EQUIPMENT
4. RE-ESTABLISH COMMUNICATIONS USING PORTABLE TRANSCEIVER EQUIPMENT

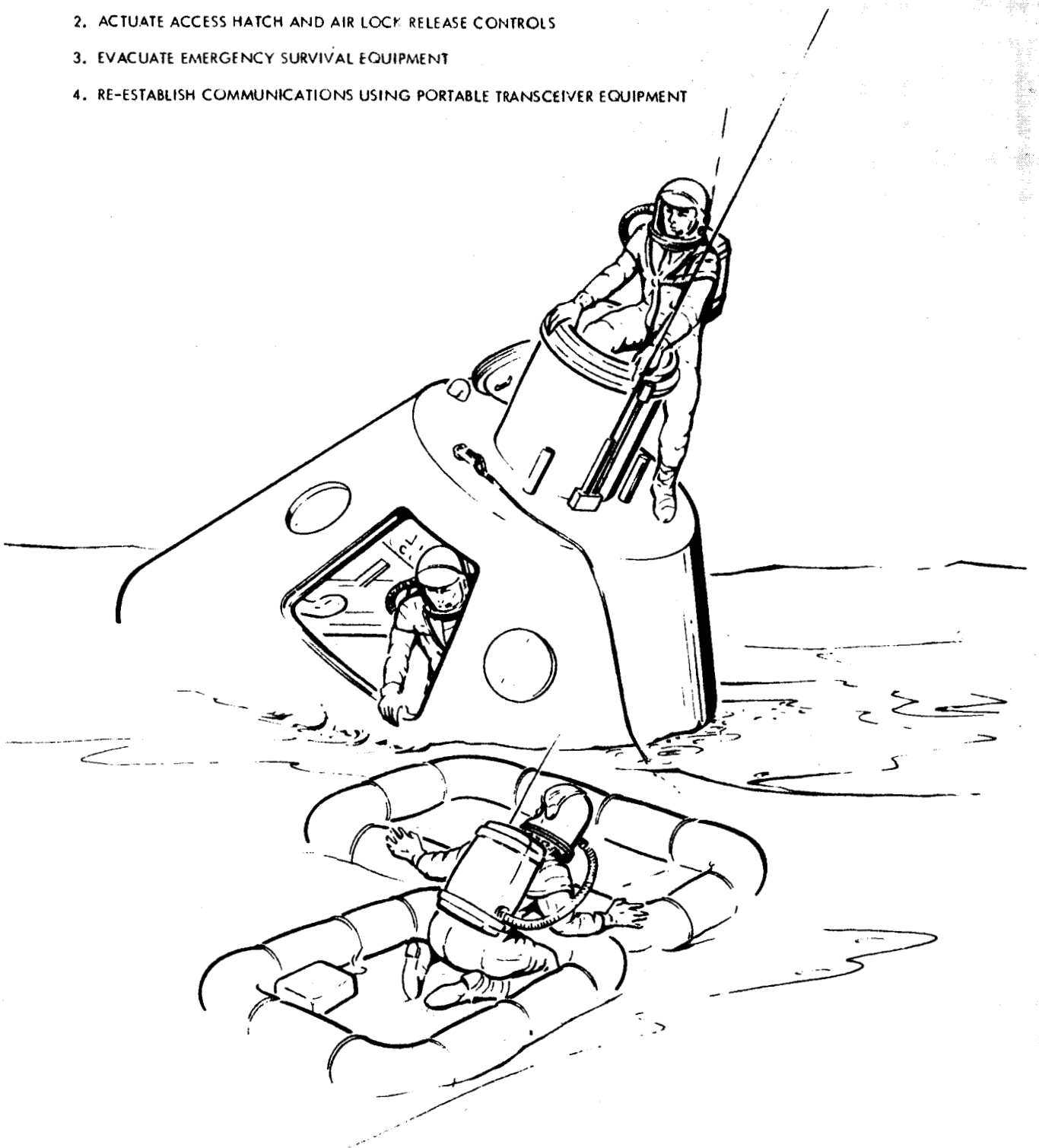


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Figure 3-1. Emergency Egress (Typical)

SECTION IV

IN-FLIGHT MAINTENANCE

Contents

NOTE

Trouble indication and remedy tables for which a heading only is included herein, will be provided when data becomes available.

- Refer to section T-1 of SM 2A2-03-CL for condensed checklist of amplified procedures contained in this section.

GENERAL

The in-flight test maintenance provided in the command module will indicate that a particular spacecraft system or component is not operating, or it is operating at an out-of-tolerance level. The spacecrew will utilize the test portion of the system to locate and evaluate the trouble, and then decide remedial corrective action.

CORRECTIVE ACTION FUNCTIONS

The spacecrew corrective action functions will entail the following:

1. Select an alternate operation.
2. Switch to redundant component or subcomponent.
3. Manually adjust component or subcomponent.
4. Perform in-place repair function.
5. Modular removal and replacement.
6. Calibrate component.
7. Reprogram mission.

IN-FLIGHT MAINTENANCE PROCEDURES

Spacecrew performance in taking remedial action is dependent upon the physical mobility of the crew within the spacecraft command module. During

short phases in which the crew is held in their restraint positions, the limit of maintenance will be to select an alternate operation or redundant system. During longer mission phases, such as translunar and transearth coast, greater crew involvement in maintenance will be exercised. Spacecrew capabilities will be employed in troubleshooting, scheduled maintenance, and repair both within and outside the spacecraft.

Trouble indication and remedy tables:

NOTE

A separate maintenance table, when provided, will contain both indication and remedy columns for each spacecraft system.

[redacted]

SID 62-786
Addendum A

APOLLO CONDENSED

CHECKLIST

SM 2A2-03-CL

30 June 1962

The procedures contained in this checklist are condensed from SM 2A2-03 Apollo Support Manual Flight Operation.

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

[redacted]

LIST OF EFFECTIVE PAGES

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NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page.

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*The asterisk indicates pages changed, added, or deleted by the current change.

INTRODUCTION

The condensed checklist consists of three parts, Normal Procedures (N-1), Emergency Procedures (E-1) and In-Flight Maintenance procedures (T-1). These checklists are condensed versions of procedures found in sections II through IV of the flight operation support manual. Emergency procedures are identified by a black and white diagonally striped border.

This checklist does not replace the amplified version in the flight operation support manual. To operate the spacecraft safely and efficiently, the crew members must thoroughly understand why each step is performed and why it occurs in a certain sequence.

NORMAL PROCEDURES

PRELAUNCH CHECKS

PRE-ENTRANCE

Procedure:

ENTRANCE

Procedure:

INTERIOR INSPECTION

Procedure:

COUNTDOWN

ESCAPE SYSTEM CHECK

Procedure:

RESTRAINT CHECK

Procedure:

N-1

EARTH ORBITAL MISSION PHASES

ASCENT

Procedure:

EARTH ORBIT

Procedure: (Automatic and manual stabilization control.)

ORBIT EJECTION

Procedure:

DE-ORBIT COAST

Procedure:

ENTRY

Procedure

RECOVERY

Procedure:

N-2

RETRIEVAL AND POSTFLIGHT

Procedure:

CIRCUMLUNAR MISSION PHASES

ASCENT

Procedure:

PARKING ORBIT

Procedure:

TRANSLUNAR INJECTION

Procedure:

TRANSLUNAR COAST

Procedure:

TRANSEARTH COAST

Procedure:

N-3

ENTRY

Procedure:

RECOVERY

Procedure:

RETRIEVAL AND POSTFLIGHT

Procedure:

LUNAR ORBITAL MISSION PHASES

ASCENT

Procedure:

PARKING ORBIT

Procedure:

TRANSLUNAR INJECTION

Procedure:

TRANSLUNAR COAST

Procedure:

N-4

LUNAR ORBIT INJECTION

Procedure:

LUNAR ORBIT

Procedure:

TRANSEARTH INJECTION

Procedure:

TRANSEARTH COAST

Procedure:

ENTRY

Procedure:

RECOVERY

Procedure:

RETRIEVAL AND POSTFLIGHT

Procedure:

N-5

LUNAR LANDING MISSION PHASES

Data to be supplied at a later date.

N-6

EMERGENCY PROCEDURES

ASCENT

OFF-PAD ABORT (PRIOR TO TOWER JETTISON)

Procedure:

SUB-ORBITAL ABORT (AFTER TOWER JETTISON)

Procedure:

LAUNCH ESCAPE TOWER FAILS TO JETTISON

Procedure:

SPACECRAFT FAILS TO SEPARATE FROM BOOSTER

Procedure:

EARTH ORBIT

ABORT FROM ORBIT

Procedure:

STABILIZATION SYSTEM EMERGENCY OPERATION

Procedure:

ENVIRONMENTAL CONTROL SYSTEM EMERGENCY OPERATION

Procedures: (Cabin depressurization, cabin pressurization, emergency oxygen and water management procedures.)

ELECTRICAL SYSTEM EMERGENCY OPERATION

Procedures: (Main battery failure, standby battery battery failure, main inverter failure, standby inverter failure, and primary electrical failure procedures.)

COMMUNICATION SYSTEM EMERGENCY OPERATION

Procedures:

NAVIGATION SYSTEM EMERGENCY OPERATION

Procedure:

PROPULSION SYSTEM EMERGENCY OPERATION

Procedure:

EJECTION

SPACECRAFT RETROGRADE SEQUENCE FAILS TO START

Procedure:

E-2

SPACECRAFT FAILS TO ATTAIN RETROGRADE ATTITUDE

Procedure:

SERVICE PROPULSION ENGINES FAIL TO IGNITE

Procedure:

SPACECRAFT FAILS TO MAINTAIN RETROGRADE ATTITUDE

Procedure:

SERVICE MODULE FAILS TO JETTISON

Procedure:

COMMAND MODULE CANNOT MAINTAIN RE-ENTRY ATTITUDE

Procedure:

RECOVERY

DROGUE CHUTE DEPLOYMENT FAILURE

Procedure:

IN-FLIGHT MAINTENANCE

CORRECTIVE ACTION FUNCTIONS

1. Select an alternate operation.
2. Switch to redundant component or subcomponent.
3. Manually adjust component or subcomponent.
4. Perform in-place repair function.
5. Modular removal and replacement.
6. Calibrate component.
7. Reprogram mission.

MAINTENANCE PROCEDURES

Trouble indication and remedy tables:

T-1